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Abstract: A 32-month old female 225-kg non-pregnant cross-bred Newsham sow presented a 6-week history of stereotypic behaviors when housed in a laboratory research facility. A behavioral examination over 12 daylight hours revealed three main stereotypic motor patterns: 1. oral-nasal gate manipulation defined as placement of the snout between the bars of the pen gate with repetitive, forceful up and down movement. 2. Head weaving defined as repetitive lateral head and snout movement towards the pen gates while rocking back and forth on her forequarters with hooves remaining on ground at all times and 3. Body weaving defined as repetitive shifting of body weight from one side to the other with front hooves lifting alternately off the ground. The sow performed the oral-nasal gate manipulation, head and body weaving 4.0%, 12.4% and 6.8% of her total baseline time budget respectively. The presumptive diagnosis was oral-nasal and locomotory stereotypies. Three treatments were employed to mitigate the duration and frequency of these stereotypic behaviors. Treatment One: Social treatment (change social stimuli by providing visual and nose-to-nose contact with different neighboring sows), Treatment Two: Forage treatment (Change foraging substrates by providing peat moss as a rooting substrate), and Treatment Three: Space treatment (Change pen configuration by increasing space). Social; The sow performed the oral-nasal gate manipulation, head and body weaving 0.9%, 15.3% and 11.3% of her total time budget. Forage treatment; The sow performed the oral-nasal gate manipulation, head and body weaving 0.5%, 28.0% and 15.5% of her total time budget. Space treatment; The sow performed the oral-nasal gate manipulation, head and body weaving 0%, 0.4% and 0.1% of her total time budget. This study is one of the first reports to evaluate treatment of established stereotypies in a mature sow. Results suggests the promise of environmental enrichment as an effective treatment strategy. Further research is needed to

evaluate the persistence of these behavioral changes and relative importance of different environmental manipulations provided.

Keywords: Swine, stereotypies, environmental enrichment, behavior modification

Case presentation

A 32 month-old 225-kg (495-lb) non-pregnant cross-bred Newsham sow presented with abnormal behavior two days after arrival to a laboratory research facility at Iowa State University. The main complaint from the caretaker was abnormal head and body weaving directed toward the front or side metal gates of the pen. The sow was housed individually in a pen that measured 3.7 m length x 1.4 m width x 1.2 m height. A rubber mat (3.5 meter length x 1.3 m width) was provided for comfort but no other bedding material was provided. The sow was able to move around freely, turn around and lie down in its pen. Metal gates were affixed at the end of each home pen and the sow was able to see outside the front and sides of the pen. Sows were housed in the adjacent right and left pens but there was no sow housed in the pen immediately across the 0.61- meter alley. The sow had *ad libitum* access to water via one nipple drinker and was hand-fed a custom mixed diet composed of corn, soybean meal and soy hulls. A daily total feed ration of 2.7 kg feed was split between morning and afternoon feedings. Matrix (Altrenogest; 6.8 ml; 15 mg) was added to one kg of feed daily to prevent estrus initiation.

History

Source farm history

According to the original source farm, no abnormal behaviors were noted in the sow's history or records. On farm, the sow was housed individually in a 0.61 meter width x 2.1 meter

length gestation stall. She was limit-fed a commercial diet composed of corn and soybean meal

once a day. The sows' reproductive history is as follows: 116 average days of gestation, 143-day farrowing interval, 14.6 average piglet number born alive and 24.8 piglets/litter/year. The sow was provided no access to enrichment material (straw, sawdust etc.) while on farm. One week prior to transport to the laboratory the sow was group housed in a 6.1 meter length X 2.4 meter width concrete pen with 11 other sows that were transported to the laboratory facility. Transportation time was approximately 50 minutes and no adverse events were noted during transportation.

Laboratory history

Two cohorts of 12 sows were transported from a local commercial sow unit and enrolled in a clinical lameness trial for seven weeks. Selection criteria for trial enrollment include multiparous, non-pregnant and non-lame sows with no clinical health abnormalities. Upon arrival, all sows underwent a seven day program where they were acclimated to laboratory facilities and equipment. This acclimation included handling, moving sows individually through the laboratory and restraint. All procedures associated with handling and restraint involved positive reinforcement through food rewards. Amongst all 24 sows enrolled in the study, only this sow demonstrated stereotypic behaviors whilst housed in her home pen.

Physical evaluation

An initial physical examination was performed on the sow upon arrival to the laboratory. The physical examination was unremarkable and included lung and heart auscultation, rectal temperature and reproductive tract ultrasonography. An 8 x 7 cm triangular alopecic area located on the dorsal aspect of the neck and a 3 cm soft tissue callus on the dorsal aspect of the nasal

bone were noted during the physical. These lesions suggest that stereotypic behavior may have

been occurring on farm prior to arrival to the lab. The sow had a body condition score three (defined as "ideal" on a one to five scale (PQA, 2013).

Behavioral evaluation

Approximately one week after arrival, a veterinarian and behavior consultant evaluated the sow's behavior. In order to define abnormal behaviors video recording of the sow was conducted over a 12-hour period (6:00-1800) utilizing continuous behavior sampling methods (Altmann, 1974). Behaviors were evaluated using two 12 V color Close Circuit Television (CCTV) Panasonic cameras (Model WV-CP484, Matsushita Co. Ltd. Osaka, Japan), positioned centrally (2.9 m from the front of the pen) using an elbow bracket at a height of 2.8 m from the floor. Video was captured digitally utilizing a Noldus portable lab (Noldus Information Technology, Wageninger, NL). The cameras were fed into a multiplexer, which then allowed the image to be recorded onto a PC using HandiAvi at 30 frames per second. A computer screen was used to view the digital video recorder output to ensure picture clarity and camera positioning prior to each behavioral recording. Behaviors of interest were identified and defined (Table 1). The duration of each behavior was quantified based on percent of time the behavior was conducted over the 12 hour video period and was considered the sow's baseline time budget (Figure 1). The sow's abnormal behavior was categorized into three main behavioral motor patterns as described below.

Oral-nasal gate manipulation

The sow placed her mouth and/or snout in between the opening of the pen gates and forcefully pushed the gate up and down repetitively. During the baseline 12 hour video

evaluation the sow performed this behavior for 4.0% of her total time budget, spending on average three seconds manipulating the gate per bout (bout defined as starting with visible movement of gate with head contact and ending when head is no longer in contact with fence for 2 seconds), with a total of 607 bouts of gate manipulation over the 12 hour period.

Head weaving

The sow positioned her head 0.61 m from the ground and conducted repetitive lateral head and snout movement towards the pen gates while rocking back and forth on her forequarters with hooves remaining on ground at all times. The sow did not perform oral manipulation such as bar chewing or object licking but she often touched the same bar with her snout or mouth (eighth gate bar from the floor). Head weaving bouts were defined as starting when head move from the resting position to either direction or pen and ending when head is stationary for more than 2 seconds) with a total of 1,154 bouts performed over the 12 hour period.

Body weaving

The sow repetitively shifted her body weight from one side to the other with front hooves lifting alternately off the ground. Body weaving bouts are defined as initiation of foot movement and body shifting to either direction of the pen and ending when body and feet arestationary for more than 1 second) performed during the 12 hour period.

Diagnosis

Based on behavioral evaluation our main diagnoses were locomotory and oral stereotypies utilizing the definition of stereotypy as a "*repetitive*, *unvarying*, *and apparently*

functionless behavior patterns" (Mason, 1991). The locomotory stereotypy was expressed as

repetitive shifting of body weight with intermittent lateral head movement. The oral stereotypy included oral-nasal manipulation of the gate. This was considered an established stereotypy as it was consistent with what was observed upon arrival to the laboratory and throughout the 6 week trial.

Treatment

Social treatment We hypothesized that changing social contacts would decrease the frequency of head and body weaving behavior. We moved the sow to an identical pen that provided social contact visually with the sow across the alley and nose to nose contact with sows on both sides of the new pen.

Forage treatment. We hypothesized that peat moss would provide a robust stimulus to increase rooting and foraging behavior and decrease the frequency of the oral-nasal gate manipulation behavior. A rubber bowl (20 cm in diameter) was filled with approximately15 oz peat moss was placed into the home pen at the base of the feed area. This location was chosen because it was the farthest from the pen gates where the stereotypic behavior was performed.

Space treatment. We hypothesized that increased physical space and access to an area outside of her original home pen would increase exploratory opportunities and decrease frequency of head and body weaving. The home pen gates were opened up to provide access to the concrete alleyway and to an additional identical pen. This increased total pen dimensions to 8 m length x 1.4 m width x 1.2 m height.

Follow-up

Social treatment: Within the first hour of treatment one, the sow spent 46.9% of her time exhibiting over 730 bouts of stereotypic behaviors .The sow performed the oral-nasal gate manipulation, head and body weaving 0.9%, 15.3% and 11.3% of her total time budget. After treatment administration the sow was placed back into her original home pen for a 24 hour recovery period (Recovery1). Stereotypic behavior did not return to baseline levels during Recovery1 day and both head weaving and body weaving increased to 28.7 and 14.7% of total time budget. Oral-nasal gate manipulation remained lower than baseline levels at 0.1% of total time budget. The sow spent 87.9% of the first hour back in her home pen exhibiting over 1200 stereotypic bouts. During treatment administration it was noted that the neighboring sow in the adjacent pen directed aggressive behaviors including lunging at the pen, biting the pen bars and attempting to bite the sow.

Forage treatment: Overall, peat moss was manipulated for only 0.1% of the total daily budget. Within the first hour of the treatment being applied, the sow spent 77% of her time exhibiting 975 stereotypic bouts. The sow performed the oral-nasal gate manipulation, head and body weaving 0.5%, 28.0% and 15.5% of her total time budget (Figure 1). After treatment administration peat moss was removed and the sow remained in her home pen for a 24 hour recovery period (Recovery2) while in her home pen. During this Recovery2 time, oral-nasal stereotypies did not change (0.5%) but head and body weaving behaviors decreased to levels more similar to baseline data (Head weaving: 10.4%; Body weaving: 3.1%; Figure 1). The sow

also exhibited similar duration and frequency of stereotypic behaviors within the first hour compared to baseline day.

Space treatment: Additional access to a pen and removal of gates was used to redirect the sow's behavior using exploratory motivation and provide access to an area outside of her home pen. The sow performed the oral-nasal gate manipulation, head and body weaving 0%, 0.4% and 0.1% of her total time budget, exhibiting all stereotypic behaviors within the first hour of treatment(Figure 1). After treatment administration pen gates were closed and the sow remained in her home pen for a 24 hour recovery period (Recovery 3). The sow exhibited 0.6%, 22.5% and 6.8% of oral-nasal gate manipulation, head weaving and body (Figure 1) with 748 of these stereotypic bouts occurring within the first hour and 81.8% of the first hour dedicated to performing these behaviors.

As this sow was enrolled in a research trial involving extra-label drug use (sow administered meloxicam at 1.0 mg/kg by mouth and flunixin meglumine at 2.2 mg/kg by intramuscular injection), it was required that all sows were euthanized at the end of the study. A necropsy was performed and gross examination of the all major organs including the brain and cranial spinal cord was examined for lesions. No gross lesions were noted during necropsy.

Discussion

Research has been conducted evaluating stereotypic behaviors in swine. This previous research provides important insights on proximate factors contributing to the causation and development of stereotypic behaviors in ungulates (Jensen, 1988; Bergeron and Gonyou, 1997; Clubb et al. 2006) as well as addressing ultimate questions on the evolutionary significance and

function of these behaviors (Mayer-Holzapfel, 1968; Bergeron et al., 2006). However, there has

been little empirical research conducted on evaluating treatment options for stereotypic behaviors in swine. The objective of our study was to describe the efficacy of three treatments to mitigate stereotypic behaviors performed by a sow in a controlled laboratory environment.

Locomotor stereotypies, like weaving, have been less commonly identified in ungulates, compromising only 10% of all stereotypic behaviors performed (Rushen and Mason, 2006). Only two studies could be found describing similar head and body weaving behavior as observed in our laboratory in swine (Fraser 1975; Cronin, 1985), suggesting that these types of locomotor stereotypies may be relatively uncommon in this species. Locomotor stereotypies have been associated with an individual's desire to reach conspecifics housed nearby (Shepherdson, 1989; Carlstead 1998), thus Social treatment was designed to change the social stimuli of the sow by placing her in a pen where she had visual access to a sow in the pen across from her, and nose-to-nose contact with two different but familiar sows. Providing a change to social stimuli did not drastically increase or decrease locomotor stereotypic behaviors, suggesting that the social environment of her home pen was not triggering this behavior performance. However, change to the expression of the motor pattern was noted in that the physical space in which she performed the behavior decreased in the presence of an aggressive neighboring sow. Upon return to the home pen, the sow's locomotor stereotypies doubled, performing stereotypies 87.9% of the first hour back. This intensity did not occur within the first hour when she was placed in the new pen, therefore is not likely associated with novelty. The intensity and frequency of the locomotor stereotypies performed suggests that the behavioral triggers may be directly associated with the original home pen environment.

It was noted that the oral-nasal gate manipulation decreased to 0.9% of the total time budget during Social treatment, reducing by over four-fold. Based on this information alone, it

may suggest that a change to social stimuli mitigated the oral-nasal stereotypy. Aggressive interactions were noted between the sow and her neighboring sow and this may have limited her ability to perform the behavior. However, upon return to her home pen during recovery1 day, oral-nasal gate manipulation dropped again to 0.1% of her total time budget and remained at or within this level for the remainder of the trial. This suggests that the decrease in oral-nasal gate manipulation was not caused by changes to social stimuli. The oral-nasal gate manipulation tended to precede head and body weaving and is possible that this behavior was used as a transition behavior to head weaving. The decrease in oral-nasal gate manipulation may be the indirect effect of changes to the behavioral pattern expressed by the sow over time.

Forage treatment was designed to change the foraging substrate provided to the sow to increase rooting and foraging behavior. Oral-nasal stereotypies are the most commonly identified stereotypies in confined ungulates, comprising 70% of all stereotypic behavior, with the most common stereotypies in sows including bar biting, sham chewing, tongue sucking, stone chewing and object licking (Sambraus, 1985, Whittaker et al, 1998; Horrell, 2000). Previous research estimates sows spend between 7%-55% of an 8 hour period dedicated to performing oral stereotypies on farm (Stall-housed- Broom and Potter, 1984; Von Borell and Hurnik, 1990). These reference levels are high compared to the 4.0% of a 12 hour period our sow performed the oral-nasal gate manipulation. Oral stereotypies have been associated with inadequate gut fill or thwarting of the appetitive and/or consummatory phases of rooting and foraging (Mason and Mendl, 1997) with previous studies successfully mitigating these behaviors using straw (Stewart et al., 2011), high fiber diets (Robert et al., 2002), and sugar beet pulp (Brouns et al., 1997).

The sow spent only 0.1% of her total time budget manipulating the peat moss. Prior to peat moss addition, oral-nasal gate manipulation decreased to 0.1% of the sow's total time

budget, no longer a major contributor to her overall behavioral repertoire. The decrease in oral-nasal gate manipulation prior to peat moss presentation made it difficult to determine if the peat moss would have been a successful treatment for this stereotypy. However, the lack of overall interest in the peat moss and the gradual elimination of the oral-nasal gate manipulation suggests that this stereotypy may not have been a true oral-nasal stereotypy driven by the sow's limit-fed concentrate diet, but may have been a transitional behavior performed between head and body weaving. Access to a foraging substrate also did not affect head or body weaving stereotypies. The lack of interest in the peat moss may have also been due to location of peat moss within the pen and more manipulation may have occurred if the peat moss was placed at the pen doors.

Space treatment was designed to change the pen configuration by increasing the space for the sow to explore and eliminating the visual barrier of the pen gates. Locomotor stereotypies have also been associated with an animal's motivation to escape aversive stimuli and are often performed at the barrier preventing them from escape (Mason, 1993; Mayer-Holazpfel, 1968). This coincides with what was noted in this study as the sow directed all head and body weaving toward the gates of the home pen.

Providing a change to pen configuration decreased the performance of all stereotypic behaviors to less than 0.5%. Interestingly, it was noted that when the stereotypic behaviors were performed, the sow directed the head and body weaving to the pen gates. In addition, the sow dedicated more time performing natural behaviors which included walking, standing, rooting, and lying compared to her baseline day. Hence, time spent performing the stereotypy was not replaced with any particular behavior suggesting obvious causation other than anxiety. Identifying a single causal factor for this mitigation is impossible as multiple factors were changed when the pen doors were opened. However, some possibilities that may have

contributed to the change in the sow's behavior include removal of the pen gate as a visual trigger, access to additional physical space for exploration, changes in olfactory and visual stimuli, and ability to escape from sows housed in adjacent pens. Cooper and colleagues (2000) evaluated five different facility types for stabled horses performing weaving stereotypies. They found that providing a front and side panel open for the horse to view an adjacent stall decreased the occurrence and frequency of weaving behavior. The authors of the publication suggested this may be due to increased environmental interaction, expression of new activities, and social interaction. Similarly weaving behavior by the stabled horse was decreased when the visual environment was modified by the use of mirrors (McAfee et al., 2002).

Oral and locomotor stereotypies were identified in an individual sow housed in a research facility over a 6 week period. The association of stereotypies with poor animal welfare encouraged our group to assess, treat and manage these behaviors being performed in the context of a laboratory setting during a trial. The greatest success occurred when the sow was provided access to additional space, reducing all stereotypic behaviors to 0.5% of the total time budget performed by the sow. This research suggests the promise of environmental enrichment as an effective treatment strategy for locomotor stereotypies in swine. However, as this was only one case study, further research is needed to evaluate several variables involved in the mitigation of these stereotypies including the persistence of behavioral changes over time, time or day effects and the relative importance of different environmental factors provided.

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Figure 1. Time budget (%) for an individual sow exhibiting stereotypic behaviors during a 12 hour observation period on baseline, treatment and recovery days.

[1] Unknown behaviors include sow out of pen or camera visual and/or camera malfunction; Maintenance behaviors (Maintenance) includes foraging, urinating and/or defecating; Body weaving behavior (Body); Head weaving behavior (Head); Oral-nasal gate manipulation (Gate)